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HYDROLOGIC RESEARCH

By Dr. ROBERT E. HORTON

VOORHEESVILLE, NEW YORK

COORDINATING AGENCY

THE fact that hydrology has largely grown up in the families of sister sciences, and the tremendous pressure for hydrologic research created by recent activities in soil and water conservation, have created a situation which seems to call for some pertinent discussion of the objectives and methodology of hydrologic research. This is especially true in view of the fact that practical applications of hydrology are running away from the scientific development of the subject. There is a consequent tendency to concentrate research on specific objectives rather than to direct it toward the development of a complete, well-rounded body of scientific knowledge.

From different view-points the objectives of hydrologic research are manifold, but, while hitherto not generally recognized, the fundamental objective of such researches, stated in its most general terms, is to determine the independent variables which govern the phenomena and the relations between them.

It is recognized that scientific research can not be standardized and that researches which have proven to be of the greatest utilitarian value have quite generally been carried out by individuals and from purely scientific motives, without regard to the application of the results. On the other hand, experience has shown that wholly undirected or uncoordinated research does not usually lead to the best results. This is especially true of researches conducted by individuals or by separate governmental bureaus or agencies. For economic reasons or through lack of interest, the research is carried only as far as needs be for the specific problem in hand. It is often true that with little additional effort, variables could be measured and the scope or limits of the research extended in such a way as to make the results valuable with reference to other re-

lated problems. This too often is left undone. The situation seems to call for some central coordinating agency, governmental or otherwise, the function of which would be to encourage, direct and generally supervise hydrologic research rather than to carry out the actual field and laboratory investigations.

It is true that in many hydrologic researches, financial aid from the government, states or other political subdivisions will be required. The expenditure of government funds is not in general permitted except through duly constituted governmental agencies. A similar situation exists in research laboratories of educational institutions. For this reason, as well as others, it is probably necessary—perhaps not undesirable in most cases—that the work should actually be done under the immediate direction of some governmental or other regularly constituted research agency.

Hydrology, even more than most other sciences, is undergoing a rapid transition from a largely qualitative to a definitely quantitative status. To attain the latter, the use of mathematical methods in the analysis of research data is necessary. It should, however, be kept in mind that mathematical analysis adds nothing to the data or assumptions on which it is based. It merely puts the results of the data and assumptions and their relations in a more concrete and intelligible form.

All hydrologic phenomena are in reality physical phenomena and are governed by the fundamental laws of physics. Many otherwise excellent hydrologic researches have suffered from lack of adequate consideration of the physical processes involved and from failure to use mathematical methods. A central coordinating agency should be able to furnish assistance of competent physicists and mathematicians to research workers, both within and outside government bureaus.

Advisory Council

It is to be borne in mind that all those engaged in water supply, water power, navigation, drainage and irrigation are directly interested in hydrologic research, but this group by no means includes all who are interested. Agriculture, forestry, environmental botany or ecology are largely dependent on hydrology. Altogether, there are far more persons directly interested in hydrologic research outside than within governmental agencies. These persons are entitled to have, and in the interests of science should have, a far more extensive part in planning and carrying out such researches than they would get if the research was carried out on a close communion basis within some governmental bureau or bureaus.

It is not an overstatement that inter-bureau jealousies often exist in relation to overlapping functions. Under these conditions coordination of scientific research among government bureaus becomes a difficult matter. This fact makes it highly desirable that there should be in every case a disinterested agency to advise in relation to the planning and execution of the work.

Before any new, comprehensive hydrologic research is undertaken, an advisory council should be set up by the coordinating agency. This council should consist of men each one of whom has outstanding knowledge of some phase of the subject. The advisory council should report to and work under the general direction of the coordinating agency. Two of its most important functions would be: (1) To prepare a correlative research report on the topic to be investigated; (2) to act in an advisory capacity in the planning and execution of field and laboratory research.

Perhaps it goes without saying, but certainly can be said without reflection on governmental employees, that men of the highest degree of knowledge and experience in hydrologic matters are not likely to be employed on governmental salaries and, if so employed, much or most of their time is taken up with administrative duties. Such an advisory committee, therefore, gives the government an opportunity to secure the benefit of the knowledge and experience of the best qualified men available. Again without any intentional reflection on governmental employees, it may be said that practicing engineers and others whose bread and butter depends more or less upon the validity of their conclusions, are likely to have a keenly whetted sense of relative values and so are well qualified to direct research in such a way as to avoid waste of time and money on unimportant matters and at the same time produce results of the greatest usefulness as well as the greatest scientific value.

In selecting an advisory board, the interrelation of hydrology to other sciences should not be overlooked. Transpiration by vegetation, for example, is one of the most important hydrologic processes, as may readily be seen from the fact that the transpiration stream of vegetation the world over transports from within the soil to the atmosphere a volume of water of the same order of magnitude as the total volume of water transported to the oceans by all the rivers of the earth. An advisory board on evaporation and transpiration research should obviously include representatives of botany, ecology, agriculture and engineering. A similar situation exists with regard to other topics.

Correlative Research

Scientific research may be broadly classified as (a) correlative, (b) laboratory, (c) field. Before any field or laboratory research is undertaken on an important topic, a thoroughgoing correlative research should be carried out to determine just what has been done on

the subject and what most needs to be done. The correlative research corresponds to the making of a map of existing highways before undertaking to complete the highway system of a region. Its importance can not be overstressed.

The correlative research should show the scope, character and results of each research previously carried out on the same subject in sufficient detail so that (a) reliable comparison can be made with other researches, (b) the future research worker can use the correlative research report with a minimum of labor in looking up library references, translating articles from foreign languages and comparing results and formulas. This means that the report on correlative research should contain a fairly complete abstract of each important previous research on the subject, giving the results, a summary of the experimental data and, if the paper contains formulas, these should be given, together with their derivation or a statement of the variables and assumptions on which they are based, and formulas for the same thing appearing in different papers or researches should be reduced to a common notation, their results compared and their limitations pointed out. As an example, there are several formulas for height of capillary rise in soils. No two of them are in the same notation and scarcely two of them are based on the same independent variables or apply within the same limits of soil texture. If empirical formulas are given in preceding work, they should be examined to determine whether they hold true for limiting conditions of the phenomenon. This is a point which is too often overlooked in the development of empirical formulas to fit a set of observations.

The preparation of an adequate correlative research on a hydrologic topic is by no means a simple matter, because of the interdigitation of different branches of hydrology and its interrelation with other sciences. There are few other sciences—perhaps none—where so large a body of existing knowledge has grown up largely unassimilated for so long a time, and is so widely scattered, as in hydrology. The data of hydrology are largely found in the literature of meteorology, botany, ecology, geology, glaciology, soil science, agriculture and engineering, in various languages and in various countries. Given an adequate correlative research as a starting point, future research workers will have at the start the benefit of the knowledge and advice of a well-qualified group, different members of which have studied the subject from different angles. In addition, the research work can be carried out with assurance that nothing of importance in previous work has been overlooked. The field and laboratory research can, on the one hand, be so limited as to avoid unnecessary repetition and, on the other hand, extended to fill gaps in previous research and provide a well-rounded body of knowledge.

Finally—and perhaps most important of all—the correlative research report should be published in full so that it may be available to all research workers interested in the subject. What is required is a small edition, a few hundred copies, of a full report containing, in abstract at least, all data and results of previous work. It may be pointed out in this connection that the defect of most present review papers published by governmental agencies on scientific topics is that a large edition is printed, with all the original data left out. Only the author's conclusions or those of the bureau or agency are thereby made available, the original data going into some governmental archive or vault where, as has been aptly stated, "only the spiders can read them."

PUBLICATION

No hydrologic research should be undertaken until provision has been made to publish the results in an adequately complete form, including at least a comprehensive summary of the experimental data. Among reasons for this are:

(1) This will permit others to use the experimental data for purposes different from that for which they were taken. It is a matter of general experience that research data may be far more valuable for some other use than that for which they were obtained. A classical example is that of the use of Picard's observation of an arc of a great circle of the earth by Sir Isaac Newton in verifying the law of gravitation.

(2) The data should be given so that any qualified person can check the conclusions. It may well be stated frankly that more than one government bureau has some idea which is practically a fetish. The bureau is loath to permit the publication of anything which conflicts with this idea. The thing needed in the publication of hydrologic research results is a relatively small edition, in reasonably complete form. This may cost little if any more than the usual, much larger, edition of a report containing only conclusions and generalities.

Another reason why research data are often omitted from publication is the unfortunate division of responsibility as between research and publication. The research agency often has little authority over the matter of publication. The head of the bureau or other research agency which secures an appropriation for research in hydrology should see to it that adequate provision for publication of the results is made at the time the research project is adopted and funds provided therefor.

INDIVIDUAL RESEARCH

There are certain forces at work which tend strongly to concentrate hydrologic research in government bureaus and to hamper outside research. This condition arises in part from the fact that research can not progress without adequate data. Herein the government agency, with its prestige and power of taxation, has a marked advantage over the individual research worker. The heads of government bureaus should, however, recognize that scientific data collected through their agencies are paid for by the public and are not private property. When a scientific research is made by a government bureau, using such data, the results of the research may quite properly be withheld until the research is completed. The distinction between basic data and researches based thereon is not as clearly kept in mind as it should be. To withhold the basic data, thereby preventing any other qualified person or agency from duplicating the research or checking the results obtained by the government bureau, is a practice which can not be too strongly condemned. Many persons give great and often undue weight to research conclusions emanating from government bureaus, failing to recognize that a government employee is merely a more or less glorified human being and is sometimes subject to human foibles and errors. This is an additional reason why the basic data collected by governmental agencies for research purposes should be available to others who are qualified to check and verify published conclusions based thereon.

There are many qualities desirable on the part of one who is to direct scientific research, particularly research on a subject like hydrology. These include unfailing patience, creative imagination, both perspicacity and perspicuity, and, above all, the ability of the research worker to observe natural processes disinterestedly and at the same time sympathetically. He must interpret as well as observe natural phenomena. Nature will always reveal her secrets if given a fair chance. Invariably it is the human and not nature who is at fault, where natural phenomena and their processes are not fully understood. Too often this results from the fact that the worker, obsessed with preconceived notions, is unable to see what lies plainly before him.

There are many men who have the patience, energy and enthusiasm, and are excellent collectors of data, but very poor scientists. It is largely for this reason that government bureaus often serve better as collectors of basic scientific data than in the conduct of research based thereon. Men possessing, even in a moderate degree, the high qualities desirable in a person who is to direct a scientific research, can not be picked at random from the personnel of a government bureau or a university faculty.

There are many instances where the best results could probably be obtained at the least expense if some degree of governmental aid could be given to individual research workers. In addition to guidance and correlative background, such workers often need, and can not themselves afford to provide, competent assistance in compiling and analyzing data and preparing drawings and other material for publication. In setting up any central organization to guide or direct hydrologic research it should be made sufficiently flexible so that in cases where desirable such assistance could be furnished.

In relation to the place of individual research in the general scheme, the following quotation from a recent paper by Samuel W. Fernberger[1] is appropriate:

> In these days when huge sums are spent—and certainly most properly spent—upon research, it is interesting to note that, with only a small plot of unused garden at his disposal, with a few common garden tools at hand in any case and with a handful of dried peas; working alone and without advice of colleagues, but with infinite imagination and with the utmost care and persistence, Gregor Johann Mendel worked out one of the great laws to be found in the history of science.

There should be no monopoly of scientific research.

ON THE ORIGIN OF THE SARATOGA MINERAL WATERS

CRYPTOZOON: PLANT NATURE AND DISTRIBUTION

By Dr. WINIFRED GOLDRING
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IN late Cambrian time (Lower Ozarkian of authors) a notable succession of barrier reefs, composed entirely of species of the calcareous alga Cryptozoon bordered the Adirondacks, stretching from the east around the southern end of this oldland through the Mohawk Valley area and westward to an unknown distance beyond the present site of Utica. Three species of Cryptozoon are known: *C. proliferum* and *C. ruedemanni* occur only in the Hoyt limestone, which is preeminently a reef formation; *C. undulatum* in both the basal Hoyt

[1] Samuel W. Fernberger, *Jour. Franklin Inst.*, 223: 2, 147–172, February, 1937.

limestone and the Little Falls dolomite. The three species are best displayed in the Saratoga area, where the reefs are, in ascending order, the *C. proliferum*, the *C. ruedemanni* and the *C. undulatum* reef (described in detail by the writer in a paper now in press as a bulletin of the State Museum).

There are several facts that indicate organic origin for these forms. *C. proliferum* develops cabbage-like heads or stocks, composed of alternating limy and sandy layers. In the "Petrified Gardens," near Saratoga, they are seen to best advantage. Here the stocks, of great size, are so crowded that they touch and the spaces between are filled with coarse sand. These facts, together with the abundance of macerated Cryptozoon material, are interpreted as indicating the outer side of the reef where conditions were more favorable to growth and storm waves broke. Approaching the shore, that is northward in this area, the stocks become smaller and are more scattered in the rocks until, as north of Lester Park, in rill channels the individuals lose their characteristic shape and have grown out into long stringers which indicate not only organic, but plant origin for these forms. The same condition is seen in the *C. ruedemanni* reef in the "Petrified Gardens." In solution crevices vertical sections of *C. proliferum* show the mode of growth, starting from a point and expanding upward, which, with the dichotomous budding so well developed in *proliferum*, is an indication of plant life. From its early discovery the association of Cryptozoon with oolites has always been noted. The constant association of fossil calcareous algae with oolitic structure and also with dolomite has been pointed out by a number of writers (see Garwood, 1913, p. 552).[1]

Cryptozoons of the same age as those in the Saratoga Springs region have been found in Dutchess County, N. Y., southward in New Jersey, Pennsylvania and Maryland and still farther south in certain formations of the Appalachian Valley through Virginia, Tennessee and Alabama and west into Oklahoma and Texas. Species have been described from lower Ordovician (Canadian) rocks of northeastern New York and western Vermont (Champlain Valley) and elsewhere in the United States and Canada. In other countries they have been reported from the Cambrian rocks of Norway, Lower Paleozoic strata of Ellesmere Land and elsewhere and from the base of the Ordovician of Eastern Asia (South Manchuria and North Korea) where the Cryptozoon reefs constitute a great display.

[1] *Geol. Magazine*, Dec. 5, 1913, 10: 440–46, 490–98, 545–53.

DIFFERENT VIEWS HELD ON THE ORIGIN OF THE SARATOGA MINERAL WATERS

By Dr. RUDOLF RUEDEMANN

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H. P. CUSHING wrote in 1914:[2] "There are few problems in geology more difficult than those concerned with the origin of the mineral waters of a specific region." This is well proved by the various views advanced by geologists and chemists. The problem of the Saratoga Springs became a prominent issue in two large lawsuits, the first between spring owners, the last one by the state against the Carbonic Acid Pumping Companies. In both these suits numerous experts were called and the mapping of the Saratoga quadrangle by H. P. Cushing and the writer was ordered in connection with the last trial. At these trials the geological and chemical experts finally testified as a rule that the water was of magmatic or volcanic origin. J. F. Kemp, one of the experts at the trials, published a full account—"The Mineral Springs of Saratoga"[3]—in connection with the second trial, in which he states that the Saratoga waters are characterized by high content of chlorids and bicarbonates of sodium, calcium and magnesium, high content of uncombined carbon dioxide and extremely small content of sulfates. He distinguishes three divisions of underground water from the standpoint of origin, *meteoric* waters derived from the rainfall, *magmatic* waters derived from cooling igneous rocks and *connate* waters, generally marine waters buried in the rocks at the time of deposit and retained in them. Then by a process of elimination he rules out connate waters because they lack sulphates in solution, and meteoric waters because we know of no chemical method by which carbon dioxide and the chlorids might be produced in such waters, and finally concludes that these constituents are likely of magmatic origin. He inferred that the carbonic acid gas, the chlorids, bromids, iodids, fluorids and sodium carbonate are of deep-seated origin and that the carbonated waters take on calcium and magnesium carbonates from the limestones and more especially from the Little Falls dolomite.

H. P. Cushing, who made the most thorough study of the geologic conditions surrounding the Saratoga Springs, agreed that the carbon dioxide and the chlorids have a deep-seated source, but ruled out volcanic or juvenile origin of the waters, because the waters are not thermal and there is no evidence of

[2] N. Y. State Mus. Bull. 169, 1914, p. 153.

[3] N. Y. State Mus. Bull. 159, 1913.

igneous action of any recency in the vicinity, or anywhere else in the eastern United States; and he especially rejected the volcanic knob at Schuylerville because he believed it at least Mesozoic in age (recent radium-lead measurements of the rock by Dr. A. C. Lane have shown it to be of Ordovician age as the present writer proposed at first). He concluded that the waters were mixed and in part may be connate and also of metamorphic origin, as urged by Ruedemann.[4] It was the writer's opinion that the carbon dioxide and some of the salts may originate in the eastern mountain regions where deeply buried sediments may still be undergoing metamorphism and impure limestones are still crystallizing into schists and producing free carbon dioxide. This is especially probable, as the source of the waters is clearly to the east and northeast.

Later, Dr. Paul Haertl, a German expert from Kissingen, who was twice called to Saratoga, in discussion with the writer recognized three possible origins of the carbon dioxide, *viz.*, volcanic, chemical (by reaction of limestone and sulfuric acid producing anhydrite and gypsum) and metamorphic by metamorphosing of limestone under pressure and heat. In his final report he favored the volcanic origin and accepted the metamorphic origin as an alternative. Dr. Herbert Ant, chemist of the Saratoga Commission, held for some time the view of the chemical origin of the gas and salts of the water in the thick deposits of Canajoharie shale, overlying the limestone and dolomite. Dr. R. J. Colony in his report to the Saratoga Springs Commission finally advanced the unusual view that the carbonic acid gas and minerals may be derived from a cooling batholith deep down below the sediments.

Dr. Brewer and Dr. Baudisch, for the first time among experts, seem now to be able to give a positive clue to the origin of at least one important element of the mineral salts, clearly pointing to a marine origin.

CHEMICAL CLUES TO THE ORIGIN OF THE SARATOGA MINERAL WATERS

By Dr. OSKAR BAUDISCH

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DIFFERENT investigators have often attempted to unfold the mystery of the origin of the Saratoga waters. These attempts could, however, remain only mere speculations, since a direct tracing of the water by special indicators was out of reach. Even the most basic and vital question whether the water comes from magmatic deep-seated sources or whether it is of meteoric origin remained unsolved.

The latest intensive geological investigation of the Saratoga basin was carried out by the late Professor R. J. Colony, of Columbia University, in 1929.[5] Colony believes that most of the constituents of the waters, including sodium and potassium, are derived from deep-seated primary rock out of which the elements are dissolved by the meteoric water supersaturated with carbon dioxide.

About barium, Colony writes: "It is possible that the barium, too, have a deep seated course, but I am not sure of it."

Colony did not like the marine hypotheses of the origin of the water; the rejection of it he expresses boldly in the following sentence: "It is inconceivable that *sulphate-free* waters can have been derived from any marine source."

The fact that the Saratoga waters do not contain sulfates has been a puzzle to most of its investigators, and it was always the reason why the marine origin of the waters had been rejected. We will see later that the absence of sulfates in the waters is easily explained and does, in fact, harmonize well with its marine origin.

Potassium, which in amount ranges from 72.33 to 750.19 parts per million, is in itself an important constituent of these waters. That Saratoga water is of marine origin can be demonstrated by studying the isotopes of the element in the different strata from which the waters come and from the water itself. In comparison with sea water, it is interesting to note the amount of sodium and potassium which has entered and remained in solution in sea water.[6]

PER KG. OF SEA WATER

	Supplied	Present	Percentage
Na	16.8 g	10.70 g	66.0
K	15.0 g	0.37 g	2.5

Potassium is very important for the life process of marine algae, and we find it in some specimens concentrated in remarkable amounts. The abundance ratio for isotopes of potassium in ocean water all over the world has been shown by Brewer to be 14.20 to 14.25.[7]

As shown in a recent paper of A. Keith Brewer and Oskar Baudisch on "The Isotopes of Potassium and

[4] N. Y. State Mus. Bull. 169, p. 165*ff*.
[5] R. J. Colony, Legislative Document, No. 70, 1930.
[6] V. M. Goldschmidt, *Jour. Am. Chem. Soc.*, April, 1937.
[7] A. K. Brewer, *Jour. Am. Chem. Soc.*, 58: 365–370, 1935.

Lithium in Saratoga Mineral Water and Cryptozoon,"[8] for the first time in the history of the geological studies of the Saratoga basin, an isotope of an element in solution, namely, K^{41}, has furnished a direct indication of the origin of the water. The result of the work of Brewer and Baudisch shows an appreciable concentration of K^{41} in the mineral water and a small concentration in the Cryptozoon formations. The overlaying shale, however, does not differ appreciably in its content from that normally present in rocks of this type.

The abundance ratio of mineral waters is 13.85 ± 0.1; of Cryptozoon, 13.95 ± 0.1.

Brewer has first published the most important and spectacular discovery that isotopes can be enriched by life processes.[9] In the last or fourth stage of evolution, we may consider that the processes of concentration of elements of the earth's crust are due to the action of living organisms. Many such processes are well known to science. For instance, certain marine organisms concentrate iodine up several hundred thousand fold as compared with sea water. According to Brewer's investigations, kelp and agar, in comparison to ocean water, possess an appreciably higher concentration of K^{41}. These marine organisms in fact concentrate the heavy potassium out of the ocean water, a most spectacular life process. By further investigations, Brewer and Baudisch demonstrated also that the marine organisms of the Cambrian Age—the Cryptozoon algae—have concentrated the heavy potassium in an appreciable amount. We find most of the potassium leached out of the Cryptozoon limestone into the water of Saratoga.

The hypothesis of the *marine origin* of the water based on this discovery is now more than mere speculation. Since we are now on solid ground and know that the Cryptozoon reefs and the Saratoga water have a direct correlation to each other and that the minerals in solution are derived at least in part from this source, we are able to say something about the appearance of barium ions in the water.

The remarkable concentration of barium by marine algae (*Fucus vesiculosus*) has been discovered in recent years.[10] While the ocean water contains only 0.02 per cent. of Ba, in the marine algae this element is concentrated several hundred fold. Among the primary rocks which contain only very small amounts of barium, the syenite with 0.2 per cent. BaO is quite outstanding. It seems to be no accident that much syenite is found in the vicinity of the Saratoga basin and barium in the Saratoga waters.

Since we find in all the different mineral springs small amounts of barium chlorid, naturally we can not expect any sulfates in the waters. Through the enrichment of barium by the life process of growing algae, the sulfur in these marine organisms must have been chemically bound to this element during geological time. Some of the sulfur is found in the Cryptozoon in the form of pyrite. In studying the constituents of Cryptozoon limestone by spectral analysis,[11] we found the following elements: Ca, Na, K, Li, Rb, Mg, Sr, Si, B, Mn, Fe, Cu and Ag. We did not find even traces of barium in the samples investigated. It is conceivable that the salty water in course of time has leached out all the barium from the Cryptozoon rocks.

The concentration of different elements and their isotopes in marine organisms of ancient and modern times furnishes a striking example of the ability and selective power of living organisms in obtaining constituents necessary for their existence.

The further study of Saratoga water and its constituents should be of scientific value not only for geochemistry but also for medicine.

[8] Brewer and Baudisch, *Jour. Am. Chem. Soc.*, 59: 1578, 1937.

[9] A. K. Brewer, *loc. cit.*

[10] Wolf von Engelhardt, "Chemie der Erde," Vol. 10, 187, 1936.

[11] Oskar Baudisch, *Arkiv Kemi, Min. och Geol.*, Bd. 12B, No. 9, Stockholm (Sweden). (1935.)

OBITUARY

FRANK NELSON BLANCHARD

HIS colleagues record with a sense of intimate personal loss the untimely death of Frank Nelson Blanchard, associate professor of zoology in the University of Michigan, after an illness of two months of bacterial endocarditis, on September 21, 1937. He was forty-eight years old. His passing leaves a conspicuous gap in the personnel of his institution.

Dr. Blanchard was born on December 19, 1888, of New England stocks which began their career in America in 1639 and 1643. Son and grandson of printers and publishers and editors, young Frank showed no inclination to follow in the ancestral footsteps. In grade school he showed great interest in batteries and other electrical devices. In high school his chief passion was for chemistry, and he fitted up a laboratory in the home cellar and busied himself in it for several years. Because of city residence, the only indication in early years of his later interest in natural history was his devotion to gardening. That devotion persisted throughout his life. In a diary which he began at the age of sixteen, and in which thereafter never a day's activities failed to be recorded,

notes on the weather and the planting, cultivation and harvesting of plants in his vegetable garden were of regular recurrence.

It was not until he attended Tufts College that his attention was turned to biology. First planning to be a forester, he came under the influence of Professor F. D. Lambert and became interested in the algae, to the extent of describing two new species during his senior year. He also studied zoology under Professor J. S. Kingsley.

The death of his father during his last college year prevented Frank's immediate entrance upon graduate work. An opportunity to teach zoology at Massachusetts Agricultural College in the summer of 1913 turned the tide of his biological interests finally in favor of zoology, rather than forestry or botany. In the vicinity of Amherst he had his first opportunity for extensive field work, and the three years spent there cast the mold of his later career.

In the spring of 1916 he was awarded a fellowship at the University of Michigan. Beginning his studies at the Biological Station of the university that summer, he received the degree of doctor of philosophy in 1919—the first Ph.D. earned under Professor, now President, A. G. Ruthven.

His interests had gradually centered upon snakes, their distribution, natural history and taxonomy. This trend was fostered by his assistantship in the natural history course given by Professor J. E. Reighard, and by his first position after completing his graduate work, that at the U. S. National Museum, where he was associated with Dr. Leonard Stejneger during the year 1918–1919.

Dr. Blanchard returned to Michigan as an instructor in 1919, and some years later, on the retirement of Professor Reighard, he took charge of the vertebrate natural history course, which has long been a unique part of the training in zoology at Michigan. His keen interest in accurate and significant observation in this course and in his own research attracted to him an enthusiastic group of graduate students. A number of those who earned the doctorate under him are now carrying on to the best of their several abilities along the lines of true scientific inquiry which he had so earnestly charted for them.

The research productivity of Dr. Blanchard was marked by its continuity. From the date of his doctorate, no year passed without a publication from him. There are at least fifty of these contributions, which range from critical reviews to important books. The large work, an illustrated "Manual of the Snakes of the United States, Canada and Lower California," on which he was engaged up to the time of his last illness, in collaboration with his student, Dr. Howard K. Gloyd, remains to be completed by his associate. The papers of Dr. Blanchard are largely on snakes, but there is a long series on the four-toed salamander, *Hemidactylium scutatum,* which show the same insistence on accuracy and relation to other things which characterizes all his other work.

One of the high lights in his scientific life was the sabbatical year 1927–1928, which he spent with his family in New Zealand, Australia and Tasmania. His recovery of the "lost frog of Tasmania," *Crinia tasmaniensis,* which for fifty years after its description was known only from the type specimen in the British Museum, and his study of its life history, with that of other Tasmanian frogs, was responsible for his only paper on foreign forms.

A later sabbatical semester enabled Dr. Blanchard to travel in the Southwest, with Dr. Gloyd, to gather material for their projected "Manual." If this excursion, because of the unfavorable time of the year, netted fewer reptiles than he had hoped, it yielded a surprisingly large crop of amateur herpetologists and other naturalists. Probably no zoologist has so assiduously sought out the non-professional workers and beginners in his field. He went far out of his way to visit them, carrying encouragement, and at the same time profiting from their efforts.

Though Dr. Blanchard published nothing on birds, he enthusiastically taught courses in ornithology both at Ann Arbor and at the Biological Station on Douglas Lake. Characteristically, he carried into this field the same extreme care which he so strongly evinced in his herpetological work. It is evidenced by the extensive series of notes which he left at the Biological Station and by the quality of his graduate students who have become accomplished ornithologists.

Shortly before his death Dr. Blanchard learned that in the forthcoming revised edition of "American Men of Science" his name was to be accompanied by the coveted star, which would mark him as one of the approximately one thousand leading scientific men of this continent. His colleagues feel a keen satisfaction in this confirmation of their judgment of him by the vote of his peers the country over. He is survived by his widow, Dr. Frieda Cobb Blanchard, assistant director of the botanical garden of the University of Michigan, and their three children.

A. FRANKLIN SHULL

DEPARTMENT OF ZOOLOGY
UNIVERSITY OF MICHIGAN

HAROLD BENJAMIN FANTHAM

THE untimely death from septicemia of Professor H. B. Fantham, Strathcona professor of zoology and head of the department at McGill University, Montreal, Canada, in his sixtieth year has removed from among us a zoologist of great research ability, an inspiring

teacher and an organizer and administrator of very great capacity. He passed away on October 26, 1937.

Dr. Fantham had a distinguished university career and held the degrees of M.A.Cantab. (Christ's College) and D.Sc. London (University College). He was a fellow of University College, London.

From 1904 onwards, Dr. Fantham was continuously engaged in university work. He held academic positions in the Universities of London, Cambridge and Liverpool and did war service as parasitologist, first with the Western Command and then in Egypt, Salonika and Malta, until he was invalided. In 1917 he became the first professor of zoology and comparative anatomy in the new University of the Witwatersrand, Johannesburg, South Africa, which post he held from 1917 to 1932. He built up a magnificent department and research school there. He served on the senate of the university, and was four times elected annually as dean of the faculty of science—no small tribute to his ability and integrity—and served for one year on the council of the university. In 1932 he became Strathcona professor and head of the department of zoology at McGill University. Under his guidance and inspiration, the zoology department attracted many students, and its numbers more than doubled. Recognizing the unique opportunity afforded by the numerous lakes and rivers for research in freshwater biology, he developed that work and soon had a number of students keenly interested therein.

Throughout his career, Professor Fantham devoted much time to research, and his many papers on parasitic protozoa, on soil protozoa, on eugenics, heredity and race admixture are well known. Practically every branch of protozoology is the richer from his contributions. He was a most consistent, logical and meticulous worker, who never spared himself. He had published over one hundred research memoirs, as well as books and magazine articles.

He was twice vice-president of the Royal Society of South Africa, was grand president of the South African Association for the Advancement of Science in 1927 and South Africa Medallist in 1931. He was one of the few non-medical fellows of the Royal Society of Medicine, was a fellow of the Zoological Society of London, the Cambridge Philosophical Society, Royal Society of Tropical Medicine and Hygiene, American Society of Parasitologists, American Association for the Advancement of Science, vice-president of the Eugenics Research Association and corresponding member of the Société pathologie éxotique of Paris. While he was in Canada, he was a regular attendant at the meetings of the American Association for the Advancement of Science and much appreciated this opportunity of meeting his fellow zoologists.

Dr. Fantham was much beloved by his students wherever he taught. He never spared himself on their behalf, and his home and library were always at their disposal. He was an artist of far more than average ability, a good speaker and public lecturer, very musical and with extremely wide interests. His fellow scientists mourn his early passing, which has left a gap that can not be filled.

RECENT DEATHS AND MEMORIALS

DR. GARDNER CHACE ANTHONY, dean emeritus of the Engineering School of Tufts College, died on November 28 at the age of eighty-one years.

PROFESSOR JOSÉ COMAS Y SOLA, director of the Fabra Observatory of the Academy of Arts and Sciences in Barcelona, died on December 2 at the age of sixty-nine years.

SIR CHARLES BRIGHT, London, an authority on telegraphy, died on November 20 at the age of seventy-three years.

THE death is announced of Dr. Ludwig Plate, who was the successor of Haeckel as professor of zoology at Jena and director of the Phyletic Museum. He had made extensive journeys to South America, the West Indies and Ceylon.

SIR GEORGE LEE, engineer-in-chief of the British Post Office and president of the British Institute of Electrical Engineers, unveiled on November 24 a mural tablet at the house where Alexander Graham Bell was born at 16 Charlotte Street, Edinburgh.

THE Physical Institute of the Moscow State University held on November 14 a memorial session for Lord Rutherford, who died on October 19. Professor Kapitsa, a member of the Academy of Sciences of the Union of Soviet Socialist Republics, who was a close collaborator for fourteen years, gave an address on his memories of Lord Rutherford.

SCIENTIFIC EVENTS

RESEARCH IN THE AMERICAN CHEMICAL INDUSTRY

ACCORDING to an article entitled "Facts and Figures of the American Chemical Industry," published by *Chemical and Metallurgical Engineering*, during the current year chemical manufacturers have spent $20,000,000, and chemical process industries several times this amount for research. It is pointed out that research in this field is of unlimited benefit in serving the public welfare, not alone in promoting health with

antiseptics, pure water, insecticides, fumigants, waste disposal, etc., as well as in purely practical ways. A few instances of the way it has lowered prices are given: "Before research one pound of iodine cost $4.50, after research, $1.30; one ampule of salvarsan before research cost $3.50 a dose, after research 20c a dose."

Products have also been improved by chemical research: "In 1910 an automobile tire costing $50 produced 5,000 miles; in 1936 a tire costing $15 will give 20,000 miles. The estimated annual savings to American motorists amount to $3,002,580,000." Chemical research has created new industries: "The production of synthetic resins in 1934 was over 100 million pounds, as compared with around 8 million pounds in 1924." It has freed industries from foreign monopolies: "Domestic production of dyes has risen to over 100 million pounds and our imports have dwindled from 50 million to about 5 million pounds a year; on the other hand, our exports have risen from nothing to about 20 million pounds annually." Out of every $100 in sales of inorganic chemicals, $2.25 is spent for research; out of every $100 in sales of organic chemicals, $4.30 is spent for research. Chemical research has resulted in:

New and improved processes.
Lower costs and lower prices of products.
New services and new products never before known.
Change of rarities to commercial supplies of practical usefulness.
Adequate supply of chemicals previously obtained only as by-products.
Freedom for American users from foreign monopoly control.
Stabilization of business and of industrial employment.
Products of greater purity.
Products of superior service, *e.g.*, light-fast dyes.
New medicines and other new health aids.
More efficient use of raw materials.
More efficient by-product recovery.

Chemical and Metallurgical Engineering writes:

Even during depression times there were in the United States approximately 1,600 industrial research laboratories with more than 22,000 technically trained men and women at work. Process industries were outstandingly first in rank as to number of laboratories, number of investigators and amount of money expended.

Educational records show the growing importance of chemical research. Nearly a third of all the doctorate degrees conferred by American universities are in the field of chemistry and chemical engineering. Over 3,000 graduate students are engaged in chemical research during their postgraduate college years. And to-day the demand for graduate degrees in chemical engineering exceeds the demand in all other divisions of engineering combined.

Research creates, chemical engineering develops and chemical industry makes commercially possible the advances of science. The result is human benefit, as well as industrial achievement, worth many times the immediate cost in dollars and cents.

THE AMERICAN STANDARDS ASSOCIATION

AT a meeting of the Board of Directors in New York City in October Dana D. Barnum, president of the American Standards Association, announced that eleven new industrial groups had joined the association since last March. These are the National Elevator Manufacturing Industry, the National Retail Dry Goods Association, the Brick Manufacturers Association of America, the Brick Manufacturers Association of New York, the American Trucking Association, the U. S. Independent Telephone Association, the Associated General Contractors of America, the American Society of Refrigerating Engineers, the Asphalt Shingle and Roofing Institute, the Heat Exchange Institute, the Hydraulic Institute.

This brings the basic membership of the association to a total number of seventy national organizations—trade associations, technical societies, departments of the federal government.

Following election in the summer two new members took their seats on the board. R. E. Zimmerman, vice-president of the United States Steel Corporation, represents the American Iron and Steel Institute, and C. E. Collens, president of the Reliance Electric and Engineering Company and past president of the National Electrical Manufacturers Association, fills the place left vacant last July by the retirement from active business of S. L. Nicholson.

As a result of the recent meetings of the International Standards Association in Paris, the United States and Italy have been invited to fill the two vacancies on the International Standards Association Council occurring through completion of the terms of Japan and Hungary. Mr. Cyril Ainsworth, assistant secretary, who attended the meetings for the American Standards Association, reported that the national standardizing bodies of seventeen countries were present. International standardization projects on aeronautics, automobiles, ball bearings, coal, navigation, tools, petroleum products, iron and steel, were among the subjects discussed. C. B. Veal, research manager of the Society of Automotive Engineers, and R. T. Brown, of the Goodyear Tire and Rubber Company, took part in the committee work on automobiles, tires and rims, and tire valves, aeronautics and petroleum products.

Among new projects, the International Standards Association is organizing five committees for standardization work in the field of acoustics—one on International Vocabulary, one on Units and Methods of Measurement, one on Electro-Acoustics, one on Archi-

tectural Acoustics and one on Noise Abatement and Vibration.

REGIONAL LABORATORIES OF THE U. S. DEPARTMENT OF AGRICULTURE

DR. JAMES T. JARDINE, chief of the Office of Experiment Stations, in his annual report to the Secretary of Agriculture states that three laboratories for the investigation of regional problems of agriculture were established last year in the program of scientific research in which the states are cooperating with the United States Department of Agriculture. A laboratory for the study of animal parasites in the Southeast, one for development of swine breeding in the North Central States and a third for sheep improvement in the Range States were approved under provisions of the Bankhead-Jones Act.

These three laboratories supplement three similar developments of the previous year—the vegetable breeding laboratory for the Southeast, the soy-bean laboratory in the Corn Belt and the pasture improvement laboratory for the Northeast—which are now well established.

Regional research has been made possible by appropriations under the Bankhead-Jones Act, which—unlike previous legislation for support of the experiment stations—requires state appropriations to offset the federal contributions. State funds not only met the new offset requirements but amounted to about $12,000,000, or slightly more than $2 from state sources for each $1 from federal grants for support of the experiment stations and approximately six times the federal grant offset requirement. Under the Hatch, Adams and Purnell Acts each state continued to receive equal appropriations. The Bankhead-Jones Act allots funds on the basis of the rural population of each state.

The laboratory for the study of diseases and parasites of domestic animals is being established at the Alabama Polytechnic Institute at Auburn. The experiment stations of thirteen southeastern states are cooperating in the development of the program. These are Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arkansas, Tennessee, Kentucky and Oklahoma.

Headquarters for the laboratory devoted to the improvement of swine through breeding methods is to be at the Iowa Experiment Station at Ames. Representatives of thirteen states in the region outlined the program, and Iowa, Minnesota, Nebraska and Missouri have agreed to participate actively. It is expected that the other nine states—Illinois, Indiana, Michigan, Kansas, North Dakota, Ohio, Oklahoma, South Dakota and Wisconsin—and possibly other states, will arrange for active cooperation.

For the improvement of sheep on western ranges, twelve range states—Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, Utah, Washington and Wyoming—are cooperating in the program which will center at Dubois, Idaho, where the department has a suitable range available from its previous work with sheep improvement. Texas is interested in sheep breeding and for this program is included as one of the range states. Plans and specifications for the laboratory required by the enlarged program of research were approved before the end of the fiscal year and the work is now going forward.

The Office of Experiment Stations continued to represent the department in administering and auditing federal contributions to the experiment stations. The office also supervises the insular stations in Hawaii and Puerto Rico. Territorial and federal work is being merged in Hawaii, and after the current fiscal year the relationships of the territorial station to the department will be virtually on a par with those of the state stations.

THE NEWLY ELECTED DIRECTOR OF THE NEW YORK BOTANICAL GARDEN

IN announcing the appointment of Dr. William J. Robbins as director of the New York Botanical Garden, the *Journal* of the garden prints a leading article which reads:

Dr. William J. Robbins, professor of botany, chairman of the department of botany and dean of the Graduate School of the University of Missouri, has been appointed director of the New York Botanical Garden. In a career which has taken him into many American research and educational institutions and into the laboratories of nearly every country in Europe, Dr. Robbins has won a reputation as a plant physiologist as well as an executive.

Born in North Platte, Nebraska, February 22, 1890, Dr. Robbins grew up in Pennsylvania, graduating from the Bethlehem, Pa., high school and attending Lehigh University in Bethlehem. After receiving an A.B. degree there in 1910, he remained to serve one year as teacher in biology. In 1911 he went to Cornell University for graduate study, beginning work for his doctorate under Dr. B. M. Duggar and completing it under Dr. Lewis Knudson, receiving his doctor of philosophy degree in June, 1915. From 1912 to 1916 he taught plant physiology at Cornell and assisted Dr. Duggar in a course at Woods Hole, Mass., during the summers of 1912 and 1913. He left Cornell in 1916 to become professor of botany in the Alabama Polytechnic Institute and plant physiologist at the Experiment Station there.

In 1918 he served as second lieutenant in the Sanitary Corps of the United States Army, spending three months of the time in the Army Laboratory School at Yale University. Upon leaving the army he accepted a position as soil biochemist in the Bureau of Plant Industry, U. S. Department of Agriculture, in the laboratory of Dr. Oswald Schreiner.

He was appointed professor of botany and chairman of the department of botany at Missouri in 1919. In the summer of 1924 he spent three months working with Dr. E. T. Bartholomew on internal decline, or endoxerosis, of lemons, at the Citrus Experiment Station of the University of California.

Beginning in August, 1928, he was associated for two years with the European office of the Rockefeller Foundation, assisting in the fellowship program, a duty which took him into the scientific laboratories of all European countries, including Russia, with the exception of Spain, Portugal, Greece and Turkey.

He was appointed dean of the Graduate School of the University of Missouri in 1930 and served as acting president of the institution from September, 1933, to May, 1934. He has been a member of the staff of the Marine Biological Laboratory for many years and was chairman of the National Research Fellowship Board in the Biological Sciences since 1931.

Dr. Robbins is a member of Phi Beta Kappa, Sigma Xi, Phi Kappa Phi, Gamma Alpha, and the honorary agricultural fraternity, Gamma Sigma Delta. He is also a Mason and a member of the Presbyterian church. This year the honorary degree of doctor of science was conferred upon him by Lehigh University.

Mrs. Robbins, who was formerly Christine F. Chapman, of Springfield, Mass., is also a botanist and a member of Phi Beta Kappa. At Wellesley, from where she was graduated in 1912, she majored in botany under Dr. Margaret Ferguson. In 1914 she received an A.M. degree from Cornell in plant physiology and then returned to Wellesley to teach in the botany department. The following year she was married to Dr. Robbins.

They have three sons: Frederick Chapman, who received his A.B. from Missouri last year and is now completing his second year of medicine; William Clinton, who will graduate from the high school at Columbia, Missouri, next spring, and Daniel Harvey, who will enter senior high school in the fall.

The results of Dr. Robbins's more than twenty years of research have been published in some forty articles which have appeared in the *American Journal of Botany*, *Botanical Gazette*, SCIENCE, *Soil Science*, and other periodicals. In collaboration with H. W. Rickett he has written "Laboratory Instructions for General Botany" and "Botany, A Text-book for University and College Students," both of which were published by D. Van Nostrand and Company. During the current year nine articles have appeared under his authorship, including: "Effect of 3-indole Acetic Acid on Cell Walls of Stem and Root" with John R. Jackson in the *American Journal of Botany*; "Vitamin B, and the Growth of Excised Tomato Roots" with Mary A. Bartley in SCIENCE; "Plant Hormones" in *School Science and Mathematics*, and "The Assimilation by Plants of Various Forms of Nitrogen" in the *American Journal of Botany*.

SCIENTIFIC NOTES AND NEWS

A LUNCHEON in honor of the eightieth birthday of Dr. William Hovgaard, professor emeritus of naval design at the Massachusetts Institute of Technology and consultant in naval construction, was given on November 27 at the Hotel Astor, New York City, under the sponsorship of the American Society of Danish Engineers, the Danish Officers Club and the Danish Luncheon Club, at which a number of naval officers and Danish engineers were present. Folmer Anderson, president of the American Society of Danish Engineers, presented to Professor Hovgaard a framed picture of *The Vigilant*, a Danish schooner used in fighting privateers off the Virgin Islands.

Nature reports that, after fifty years devoted to teaching and research, Professor Charles Fabry, distinguished for his work in optics, is retiring from the chair he has held in the Sorbonne, Paris. It was planned to celebrate his scientific jubilee by a meeting to be held at the Sorbonne some time between November 23 and December 5. The committee in charge of the arrangements has approved the design of a Fabry Jubilee Medal. It is also hoped to be able to publish in volume form some of Professor Fabry's works, selected from his classical memoirs and from his unprinted researches.

DR. HENRY A. PILSBRY, curator of the department of mollusks at The Academy of Natural Sciences of Philadelphia, celebrated, on December 1, his fiftieth anniversary as a member of the staff. During this period he has made twenty-three field trips and expeditions to various parts of the United States, Mexico, Hawaii, Australia, Central America, the Caribbean and the islands of the Southern Pacific in 1929. In addition to his editorship of the *Nautilus* and the "Manual of Conchology," Dr. Pilsbry has written some 800 scientific papers. He is now at work on a manual of the land mollusks of the United States.

A DINNER in honor of Dr. Marie Reimer, professor of chemistry; Dr. Harry L. Hollingworth, professor of psychology, and Dr. Edmund W. Sinnott, professor of botany, of Barnard College, Columbia University, was given recently by the Barnard College Club. Dean Virginia C. Gildersleeve presided, and addresses were made by the guests of honor.

A TESTIMONIAL dinner was tendered on November 21 by the trustees of Brooklyn College of Pharmacy to Dr. Hugo H. Schaefer, the newly elected dean of the college.

GEORGE M. L. SOMMERMAN, formerly an engineering student at the Johns Hopkins University, has been awarded the Alfred Noble prize of $500 for a paper entitled "Properties of Saturants for Paper-insulated

Cables." The award, which was established in 1929, is made annually for a paper accepted by the publication committee of five engineering groups. The author must be under thirty years of age. The money for the award comes from a fund contributed by engineers in honor of the late Alfred Noble, past president of the American Society of Civil Engineers and of the Western Society of Engineers.

ROBERT E. SNODGRASS, senior entomologist of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, has been elected an honorary fellow of the Royal Entomological Society of London. Honorary membership in this society is limited to twelve. Other Americans who have been elected honorary fellows are Dr. L. O. Howard, formerly chief of the Bureau of Entomology, and the late Professor W. M. Wheeler, of Harvard University.

THE "Adlerschild" of the German Empire has been awarded to Dr. Bernhard Nocht, professor of tropical hygiene at the University of Hamburg.

OFFICERS to be installed at the Minneapolis meeting of the American Pharmaceutical Association are: *President,* J. Leon Lascoff, New York, N. Y.; *First Vice-president,* A. O. Mickelsen, Portland, Ore.; *Second Vice-president,* Geo. A. Moulton, Peterborough, N. H.; *Members of the Council,* Roy B. Cook, Charleston, W. Va., Glenn L. Jenkins, Minneapolis, Minn., and R. L. Swain, Baltimore, Md.

AT a meeting of the New York Academy of Medicine on December 3 Dr. Benjamin P. Watson was elected vice-president of the academy to succeed Dr. Herbert B. Wilcox, who was elected a trustee. Dr. Frederic E. Sondern, formerly president of the Medical Society of the State of New York, was reelected a trustee.

OFFICERS of the Cambridge Philosophical Society for 1937–38 are: *President,* Sir F. Gowland Hopkins; *Vice-presidents,* Dr. C. G. Darwin, F. P. White, Professor J. Gray; *Treasurer,* Dr. J. D. Cockcroft; *Secretaries,* A. H. Wilson, Dr. O. M. B. Bulman, J. A. Ratcliffe; *New Members of the Council,* Dr. N. Feather, Dr. C. F. A. Pantin, E. N. Willmer.

DR. WALTER H. DURFEE, professor of mathematics and head of the department of mathematics at Hobart College, has been appointed dean of the college, the appointment to take effect on September 1, 1938. He will succeed Dr. Milton Haight Turk, a member of the faculty since 1890 and dean since 1925. Dr. Durfee is the son of Dean Emeritus William Pitt Durfee, professor of mathematics, the first dean of Hobart College.

DR. N. J. BERRILL and Dr. V. C. Wynne-Edwards have been placed in charge of the department of zoology at McGill University pending the appointment of a successor to fill the vacancy created by the death of Dr. H. B. Fantham, Strathcona professor of zoology and head of the department. Dr. Annie Porter Fantham, wife of the late Dr. Fantham, is continuing in the department as a research fellow.

PROFESSOR A. J. ALLMAND has been appointed, from August 1, 1938, to the Daniell chair of chemistry at King's College, University of London.

THE title of emeritus professor has been conferred by the University of London on Professor Thomas Yeates, on his retirement from the S. A. Courtauld chair of anatomy at the Middlesex Hospital Medical School.

DR. LIVINGSTON FARRAND, president emeritus of Cornell University, has been elected a member of the board of governors of the Society of the New York Hospital. Dr. Farrand will be one of the twenty-four governors constituting the board, and the three hundred and seventy-sixth member to be elected since the society received the charter from George III in 1771.

C. H. PIERCE, senior engineer of the Geological Survey, has been temporarily detailed to the National Resources Committee to assist the special subcommittee of the Science Committee in the investigation that is being conducted of the relations of government to research. The work of this special subcommittee is being carried on under the direction of Dr. B. M. Woods, of the University of California. Walter B. Langbein, assistant engineer of the Geological Survey, is also assisting in this work on a part-time basis.

DR. ERIC PONDER, of the Marine Biological Laboratories at Cold Spring Harbor, L. I, was elected president of the American Medical Graduates' Club of the University of Edinburgh at the second annual reunion, held on November 28. A cablegram of greeting from Sir Thomas Holland, principal of the University of Edinburgh, was read at the meeting.

THE following scientific men were present on November 22 at a dinner given in London of the General Council of the British Trades Union Congress: Sir John Orr, Professor J. B. S. Haldane, Professor P. M. Blackett, Professor G. Barger, Professor Lancelot Hogben, Professor A. C. G. Egerton, Sir Frederick Hopkins, Dr. J. D. Bernal, Sir Richard Gregory, Professor P. G. H. Boswell, Sir Daniel Hall and Professor F. G. Donnan. The gathering had been arranged so that the General Council might consult with representative scientific men on the possibility of establishing a Scientific Advisory Council.

DR. CHARLES R. STOCKARD, professor of anatomy at Cornell University Medical College, on December 3 gave the first of two lectures in the newly established Joseph Collins research lectureship, endowed by Dr. Collins for promulgating knowledge in the field of

neurology and neuro-psychiatry. The lecture was the ninety-first anniversary discourse of the New York Academy of Medicine.

DR. CECIL K. DRINKER, professor of physiology in the School of Public Health of Harvard University, will deliver the third Harvey Society lecture of the current series at the New York Academy of Medicine on December 16. Dr. Drinker will speak on "The Functional Significance of the Lymphatic System."

DR. ISAIAH BOWMAN, president of the Johns Hopkins University, will deliver the inaugural address at the installation of Dr. Oliver C. Carmichael on February 3, 1938, as chancellor of Vanderbilt University.

PROFESSOR STEPHEN TIMOSHENKO, of Stanford University, will lecture at the Iowa State College on December 13 on "Recent Research Work in European Material Testing Laboratories," at a meeting of the local chapter of Sigma Xi. He will speak also under the auspices of the Graduate College on "Impact Effect on Bridges."

THE new laboratory near Lansing of the Michigan State Department of Health, which was built at a cost of $250,000, was dedicated on November 12. Dr. Frederick G. Novy, dean emeritus of the medical school of the university, who assisted in establishing the first public health laboratory of the state in 1887, gave the address at a banquet given under the auspices of the Michigan branch of the Society of American Bacteriologists and directors of registered laboratories.

A CONFERENCE to collate the results of researches in the combustion and economy of anthracite together with experience in its production, preparation, distribution and utilization will be held on April 29 and 30 at Lehigh University. Reports on some of the non-fuel uses of anthracite will also be included in the program. The conference, which is expected to bring together authorities in the field, has been assured the support and cooperation of leaders in the anthracite industry. Professor Howard Eckfeldt, head of the department of mining, and Allen Johnson, research engineer, are in charge of arrangements for the conference.

THE *Journal* of the American Medical Association reports that the California Medical Association has prepared a program of graduate education to be delivered throughout the state over a five-year period. The conferences will be clinical and not didactic. The University of California, Stanford University, the University of Southern California and the College of Medical Evangelists will cooperate with the state medical association by making available members of the faculties as instructors for these conferences. The California Tuberculosis Association, the California Heart Association and the Los Angeles County Clinical Statistical Association, on request, will recommend members of their organizations for teaching tuberculosis and heart disease. In addition to the specialties, the courses will cover abdominal disease, diseases of metabolism, genito-urinary and venereal infections, diseases of the central nervous system, laboratory equipment and technique, drugs, vaccines and serum.

UNDER the terms of the will of Mrs. John V. Hansen more than $250,000 will ultimately become the property of Lehigh University. The will directs that on the death of Mr. Hansen the principal be turned over to Lehigh University as a scholarship fund in memory of her father, the late James Clark Haydon, coal mine owner of Hazleton, Pa.

THE new state cancer hospital authorized by the 1937 legislature of Missouri will be constructed in Columbia, conditional on the city donating a 40-acre site, which already has been tendered to the state without cost. Construction work will be started next spring, as soon as weather conditions permit. It is estimated that about 18 months will be required to complete the hospital. The legislature appropriated $400,000 for construction of buildings, $100,000 for equipment and $100,000 for maintenance for one year.

GUY'S HOSPITAL, London, has received a gift of £43,000 from "Five Friends" for the provision of a psychiatric clinic. The clinic will deal with minor mental illnesses and with major mental illnesses which are not certifiable. The new building will be erected within the grounds of the hospital and will provide forty-two beds for patients of moderate means, in addition to the six beds which are already provided by the hospital for psychiatric cases. The clinic will be the first of the kind in Great Britain to be associated with a general teaching hospital and will provide opportunities for investigation which can not be obtained in any other way.

DISCUSSION

CRYSTALLIZED VITAMIN C AND HEXURONIC ACID

THE well-merited award to Albert von Szent-Györgyi of the 1937 Nobel Prize in Physiology and Medicine "for his discovery of the biological processes of oxidation with special regard to vitamin C and the fumaric acid catalyses" is erroneously interpreted in many quarters solely as an award for the identification of vitamin C. Reports on crystalline vitamin C are sufficiently clear that no such interpretation should

be made, but numerous careless or erroneous statements have appeared in scientific journals, reviews and books and in lay publications, which tend to obscure the priority of Dr. C. G. King and W. A. Waugh, of the University of Pittsburgh, in establishing the identity of vitamin C with a pure crystalline substance.

In 1927 Szent-Györgyi[1] made the first statement concerning a reducing substance which he had not yet isolated in crystalline form. He designated it C_{XII}, an apparently fortuitous use of the letter "C" and with no implication that it was related to vitamin C.

Again in 1927 Szent-Györgyi stated:[2]

> To exclude any anticipation of function and chemical structure, the substance giving this reduction was named by its protocoll number "C_{XII}" being the twelfth substance prepared and examined in my work on tissue oxidation and the function of the adrenal cortex. Having been enabled to resume this work at the Biochemical Laboratory, Cambridge, the substance has been further investigated and finally isolated in crystals, which on recrystallization showed a constant melting point.

And

> Preliminary experiments tend to show that the substance is not devoid of biological activity. My earlier experiments, showing that C_{XII} is not the hormone of the adrenal cortex, seem in the light of Banting's and Rogoff and Stewart's recent work to be inadequate. Analysis of the biological significance and chemical constitution has been started.

Zilva[3] on May 7, 1932, wrote:

> Ever since Prof. A. Szent-Györgyi suggested the possible identity of hexuronic acid[4] with the "reducing principle" present in all active antiscorbutic solutions . . .

The paper[4] to which Zilva refers contains the following sole reference to vitamin C:

> The reducing properties of plant juice have repeatedly attracted attention, especially from students of vitamin C. Bezssonoff has applied Folin's phosphomolybdic acid reagent. The reducing substances of lemon juice have been made the object of a thorough study by Zilva, who established interesting relations between vitamin C and the reducing properties of the plant juice. The main reagent employed by Zilva was phenolindophenol. Indophenol blue is readily reduced by the hexuronic acid, so that it is probable that it was this substance which has been studied by Zilva.

The title of Zilva's paper[5] (received for publication on August 25, 1932), "The Non-Specificity of the Phenolindophenol Reducing Capacity of Lemon Juice and Its Fractions as a Measure of Their Antiscorbutic Activity," succinctly reveals that Zilva did not believe that the reducing substance with which he had dealt in a series of investigations was identical with vitamin C but a substance associated with it. Since Szent-Györgyi, as quoted above, believed "that it is probable that it was this substance which was studied by Zilva," then hexuronic acid was identified by Szent-Györgyi in 1928 with a substance associated with vitamin C but not vitamin C itself.

Tillmans, Hirsch and Hirsch[6] in January, 1932, stated (in a note added at proofreading) in regard to Szent-Györgyi's 1928 paper:

> Die Frage der etwaigen Übereinstimmung dieser Substanz [hexuronic acid] mit dem vitamin C wird von Szent-Györgyi nicht aufgeworfen. Er ist vielmehr der Ansicht, dasz dieser Stoff in der Oxidationsmechanismus des Peroxydase-Systems eingeschaltet ist.

This note expresses an independent opinion that Szent-Györgyi did not consider hexuronic acid to be vitamin C.

McKinnis and King[7] in 1930 established the acidic nature of vitamin C, and in discussing the acidity said:

> It is also of interest in relation to the close association of vitamin C with the actively reducing uronic acid isolated by Szent-Györgyi.[4]

That the idea was current among King's students that vitamin C was a uronic acid is further evidenced by the statement in 1931 by Smith and King.[8]

> In view of the fact that the active preparations were always characterized by a high content of strongly reducing substances and acidic material analogous to the "hexuronic acid" isolated by Szent-Györgyi, it was thought desirable to find out whether the use of a strongly reducing, weak acid, such as formic, would prove advantageous in protecting the concentrates.

In a review of the work on vitamin C during 1932, Harris[9] contributes a parenthetical statement of significance:

> Early in 1932 Szent-Györgyi, in collaboration with Svirbely (who, it may be recalled, had lately been associated with King in work on vitamin C concentration at the University of Pittsburgh), announced . . .

On April 1, 1932, as the culmination of a series of studies concerned directly with vitamin C, King and Waugh[10] announced the isolation of vitamin C in crystalline form. They said:

[1] *Biochem. Zeits.*, 181: 433, 1927.
[2] *Nature*, 119: 782, 1927.
[3] *Nature*, 129: 690, 1932.
[4] *Biochem. Jour.*, 22: 1387, 1928.
[5] *Biochem. Jour.*, 26: 1625, 1932.
[6] *Zeits. Untersuch. Lebensm.*, 63: 1, 1932.
[7] *Jour. Biol. Chem.*, 87: 615, 1930.
[8] *Jour. Biol. Chem.*, 94: 491, 1931.
[9] *Ann. Rev. of Biochem.*, 2: 264, 1933.
[10] SCIENCE, 75: 357, 1932.

The recrystallized substance corresponds in chemical and physical properties to a hexuronic acid, and is apparently identical with the hexuronic acid described by Szent-Györgyi and reported as a reducing factor in adrenal cortex, cabbage and other sources. Feeding approximately 0.5 mg. daily protects growing guinea pigs from scurvy and permits normal vitality in the animals when on a vitamin C free diet. A detailed account of the experimental work will be published in the near future, but this involves only a few steps beyond the work previously published.

On April 16, 1932, Svirbely and Szent-Györgyi[11] announced that they had, by means of 1 mg of hexuronic acid daily, protected guinea pigs from scurvy in an experiment lasting 56 days. Because of the unavailability of milk powder for making the basal diet this test was unfortunately marred by loss of weight of all animals. A current experiment with a satisfactory diet was in progress, and three animals which had received 1 mg of hexuronic acid for 55 days were found to be free of scurvy. However, it was not until May 7, 1932, that Svirbely and Szent-Györgyi[12] stated that hexuronic acid is vitamin C. They said:

> This allows us to conclude that vitamin C is a single substance and identical with hexuronic acid.
>
> Simultaneously with our previous note, C. G. King and W. A. Waugh[10] reported that they have obtained, from lemon juice, crystals which showed antiscorbutic activity and were apparently similar in chemical and physical properties to hexuronic acid. The duration of the test period was not stated, and apparently no chemical analysis was made. Until this is done, the nature of their product remains in doubt.

The results of Waugh and King[13] and those of Svirbely and Szent-Györgyi[14] were published in full in 1932. Subsequent studies by others have shown that vitamin C had indeed been identified.

The following facts in chronological order are evident from the above analysis of the statements appearing in the literature:

(1) Szent-Györgyi first isolated "hexuronic acid" but viewed it only as a reducing substance associated with vitamin C (1928).

(2) McKinnis and King first published a positive suggestion that hexuronic acid is vitamin C (1930).

(3) King and his students carried out a sustained study of vitamin C resulting in the isolation of the active substance in the crystalline form and first stated that the crystalline substance was apparently identical with Szent-Györgyi's hexuronic acid (April 1, 1932).

(4) Fifteen days after King and Waugh published, Svirbely and Szent-Györgyi gave their first evidence that hexuronic acid has anti-scorbutic properties, but it was not until May 7, 1932, that they stated that "Vitamin C is a single substance and identical with hexuronic acid."[12]

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11 *Nature*, 129: 576, 1932.
12 *Nature*, 129: 690, 1932.
13 *Jour. Biol. Chem.*, 97: 325, 1932.
14 *Biochem. Jour.*, 26: 865, 1932.

NON-TRANSMISSIBILITY OF TRICHINELLIASIS IN PIG

A sow with a bodyweight of about 550 pounds has been fed Trichinellas on the 35th, 56th, 80th and 103rd day of its pregnancy. Each time about 3,000 Trichinellas have been given. The age of the Trichinellae, which had been raised in mice from a strain originally isolated from pork sausages, was from three to four months.

The sow farrowed a litter of eleven pigs eleven days after the last infection. About two weeks later lactation ceased.

Six of the young pigs have been autopsied and their striated muscles digested during the first three weeks after birth; similarly, the remaining five pigs during the next three weeks. In none of the little pigs could Trichinellas be found. The diaphragm of the sow contained 434 Trichinellae per gram of muscle.

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THE PROGRESSIVE CONFUSIONAL SYNDROME FOLLOWING INJURIES TO THE CERVICAL PORTION OF THE SPINAL CORD[1]

IN a large proportion of cases of fracture of the cervical vertebrae, mental symptoms of loss of memory, confusion, hallucination and even delirium have been observed. Such symptoms have usually been considered the result of cerebral contusion or concurrent disease, and so of course they may be in many instances. Similar symptoms have been observed, however, in six cases of non-traumatic injury to the spinal cord which are being reported in more detail elsewhere. One of them was a chordotomy for pain, two chordotomies for athetosis, one a pathologic fracture from tuberculosis of the spine, one a spontaneous hematomyelia and one a rapidly progressing sarcoma. All the patients died; in three the circulation appeared to fail before the respiration.

1 From the Neurological Unit, Boston City Hospital, and the Department of Neurology, Harvard Medical School.

In searching for a cause for the syndrome, the possibility that deficient aeration played a part in it naturally suggests itself. The sequence of events is much like that described in "mountain sickness" and certain cardiac psychoses. While the respiration was regular and of approximately normal rate, the action of the intercostal muscles was feeble or absent in all cases. Slight cyanosis was often observed. Atelectasis of the lungs was observed at autopsy in three of the cases. Studies of the oxygen content of the arterial blood in three cases showed it to be reduced in all, and in one at a level at which symptoms might be expected.

Another possibility is that the syndrome is due to interruption of vasomotor pathways or of sensory tracts. The physiologic aspects of the condition are being studied further under a grant from the Committee on Scientific Research of the American Medical Association.

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"IDEST"

ONE may profit by Mr. Charles H. Briggs's warning against ambiguous use of "or" (SCIENCE, November 5) without accepting his proposal to substitute "idest" (Latin *id est*) where the terms connected are equivalent. Equivalence is unmistakably implied by the use of commas in the phrase "A, or B, . . ." Conversely, "A or B . . ." should imply that A and B are non-equivalent, and it would do so if all readers knew the rule and trusted all writers to know and apply it. But there's the rub! Mr. Briggs evidently distrusts, in this regard, the writer of the phrase "gauze or leno"—and so do I, after having found from the dictionary that leno is a kind of gauze.

A writer who wishes to make the non-equivalence of two terms connected by "or" unmistakable even to a distrustful or a careless reader, or to emphasize it for any reason, can do so at the cost of an extra word or two (*e.g.*, "either A or B"; "of A or of B"). Equivalence, on the other hand, may be emphasized by substituting dashes or parentheses for commas, or by inserting "that is" or "*i.e.*" (usually read as "that is"). Mr. Briggs mentions all these devices only to reject them. He stigmatizes "that is" and "*i.e.*" as "awkward and interruptive." But it seems to me that neither they nor the punctuation marks interrupt the reader; he takes them in his stride because they are familiar. "Idest," on the contrary, will slow up most readers, even though it be defined in a footnote for each article in which it appears, unless and until it becomes so broadly accepted as to be "an English word," which it is not now.

But "idest" may appeal to those who use "A and/or B" instead of the plain English, "A or B or both"!

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SCIENTIFIC BOOKS

CALCULUS

Differential and Integral Calculus. By RICHARD COURANT. Translated by E. F. MCSHANE. Blackie and Sons, Ltd., London and Glasgow. New York: Nordemann Publishing Company, Vol. I, xiii + 568 pp., 1934 ($5.00); Vol. II, x + 682 pp., 1936 ($7.00).

EXCELLENT treatises on advanced differential and integral calculus are as valuable as they are rare. Such a treatise can do much to spur the student of marked mathematical ability to go on beyond the beginnings of the calculus and can help greatly in deepening and making effective the knowledge of those who wish to use the calculus as a tool in some of its varied applications. And yet only two English works of this kind seem to me to have been available in the last two decades: I refer to the well-known books written by Osgood and by Edwin B. Wilson. The two volumes of Courant's "Differential and Integral Calculus" here under review form a third distinctive treatise of high quality. This comes as a translation and extension of his well-known German work on the same subject. As in the other cases mentioned, Professor Courant's presentation is a labor of love. Its pages are steeped with a broad and appreciative mathematical spirit which is deeply interested in purely mathematical considerations, but at the same time recognizes the importance of the numerous applications. Of their significance no one is more aware than Professor Courant, whose mathematical text-book for physicists, written in collaboration with Professor Hilbert, has proved extraordinarily useful.

The two volumes have the great advantage that they are written so clearly and at such length (some 1,250 pages) that they can be read without the fatiguing necessity of weighing each word, which too often confronts the reader of a mathematical book. Furthermore, the style is lively and the matter is treated from a modern point of view by one who is himself a distinguished mathematician, which makes the reading interesting in detail. Differential calculus and integral calculus are introduced side by side.

The ground covered in the two volumes is extensive. In fact, such a subject as uniform continuity is soon introduced in the first volume, while the last 150 pages of the second volume deal with differential equations, the calculus of variations and functions of a complex variable. The precise limitations of the

material will be best indicated to mathematicians by saying that the Lebesgue integral is nowhere mentioned —a limitation which to the reviewer seems a wise one. As an instance of this material may be mentioned Harald Bohr's simple theorem that $y = \log \Gamma(x)$ is the only "convex" solution of the functional equation $y(x+1) - y(x) = \log x$ such that $y(1) = 0$. This shows the interesting fact that the gamma function, $\Gamma(x)$, is uniquely characterized in the real domain by its well-known functional equation and the condition that $\log \Gamma(x)$ is a convex function.

It is certain that all American mathematicians will feel grateful to the author, Professor Courant, and also to the translator, Professor McShane, for their cooperation in making this excellent text-book immediately available to our mathematical public.

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RADIOACTIVITY

Radioactivité. By MADAME PIERRE CURIE. Paris: Hermann et Cie, Editeurs, 6, rue de la Sorbonne. 563 pp., price, 150 Fr., 1935.

FINISHED in 1934 at the death of Madame Marie Curie and seen through the press by Irene Curie-Joliot and Frederic Joliot, this book deals mainly with the classical phenomena of radioactivity. The first part (p. 1–125), serving as a brief introduction into modern physics, has as a sub-title: "Ions, Electrons and X-rays." It contains in some detail the more old-fashioned methods of ionization measurements; modern equipment (counters, Wilson cloud chamber, etc.) are referred to in the second part, but only briefly. The treatment of the many phases of modern physics touched upon is rather sketchy, but references are given in this first part to more extensive texts for the student who wishes to study the different subjects in detail.

The second part of the book is devoted to radioactivity proper. The discovery of the radio elements and the chemical methods of extraction and purification are discussed in some detail. The theory of radioactive transformations is developed and illustrated with examples; the analysis of the decay curves is carried out for the most important cases. The chapters that follow (203–335) are devoted to the discussion of the radioactive radiations and their properties. In these chapters the results of the modern investigations (both experimental and theoretical) are given, but without derivations or any detailed discussion.

Artificial disintegration, the discovery of the neutron, the positron and of artificial radioactivity are briefly discussed (p. 367–389). A few pages (389–401) are given to the discussion of the structure of the atom and the modern theory of radioactive disintegration. The remaining chapters deal with the effects produced by the radiations, the classification of radio elements and their chemistry and a brief discussion of radioactive families. An appendix contains numerical tables useful for the student of radioactivity.

Throughout the book facts and not problems are discussed. A serious handicap for the student and the non-specialist who wants to study the subject is the complete absence of literature or quotations. The book which covers the work done over a period of more than 30 years will be of small value for the beginner, for whom, according to the plan, it is intended because of this serious lack of references. Since derivations are only given for the most elementary formulae, it is necessary to consult the originals to understand the full meaning of the results. This, however, has to be done by using other references, since no quotations are given where, or even when the work was published. An appendix giving the necessary references would enhance the value of the book considerably. A number of excellent photographic plates accompany the discussion of the different subjects.

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SPECIAL ARTICLES

DETECTION OF CRYSTALLINE SILICA IN LUNG TISSUE BY X-RAY DIFFRACTION ANALYSIS

IN the analysis of lung tissue for silica, present chemical methods permit only the estimation of total silica. It is not possible to differentiate between free and combined silica or between crystalline and amorphous silica. When such a differentiation is attempted by the application of petrographic methods to a study of lung ash, the results are frequently unsatisfactory because, first, the silica may react with the alkaline constituents of the ash at the high temperature (500° C.) necessary for the elimination of carbon and, secondly, the particles may be so small that they can not be rigorously identified. It is thus highly desirable to develop a procedure for the study of the inorganic constituents of lung tissue which does not involve the destruction of the organic matter and which may be applied to particles of extremely small size. Our preliminary experiments, which we are now reporting, indicate that such a procedure may be based upon an application of a suitably refined x-ray diffraction technique.

In the present investigation the lung tissue was hardened in a dilute solution of formaldehyde, dried in vacuo at 70° C., ground to pass a 40-mesh sieve,

and dried further to constant weight at 105–110° C. Following a chemical analysis for total silica, according to the method described by Sweany, Porsche and Douglass,[1] very thin samples (0.2–0.3 mm in thickness) were subjected to diffraction analysis. The x-ray beam, collimated by two 0.020-inch pinholes, was supplied by a Philips-Metalix tube with a copper target, operating at 20 ma. under an applied potential of 27KVP. The use of thin specimens necessitated exposure times as long as 14 hours, but it was found that with this type of sample, the large amount of organic material present did not mask the pattern of the inorganic constituents. The effect of the tissue was noted in the scattering near the central spot and in the broad halo 3.6 cm in diameter (5.0 cm plate to specimen distance).

In the case of a lead and zinc miner, who had been exposed to silica dust for 40 years and who died of silicotuberculosis, the chemical analysis of the dry lung tissue showed a silica content of 0.90 per cent. (ash 5.38 per cent.), and the diffraction pattern showed very distinctly the characteristic 3.34 A. U. spacing of quartz. Likewise, the lung tissue (silica 1.02 per cent., ash 13.32 per cent.) of a rock miner, who had been exposed to dust for a period of 18 years and who died 8 years later of silicotuberculosis, gave an x-ray diffraction pattern on which this quartz spacing, in addition to numerous other lines, was clearly discernible. In marked contrast to the above is the case of a 72-year old man who had farmed all his life. The lungs showed multiple healed nodular calcifications. Although the silica content was 0.63 per cent. (ash 13.72 per cent.), there were no pathologic evidences of silicosis. In the x-ray diffraction pattern there were several lines closely resembling those given by a typical tuberculous calcification, but the 3.34 A. U. line of quartz was absent. Hence, we may conclude that quartz was not present in any appreciable quantity and that the silica indicated by the chemical analysis was probably largely derived from silicates. Here, then, is a possible explanation of the fact that no silicotic condition existed, even though the silica content was about six times that of normal lung tissue and three times the amount that usually produces silicosis.

In the study thus far it has been possible to detect quartz in lung tissue containing as small an amount as 0.26 per cent. silica. Further refinements of technique incorporating the application of the recently reported monochromators may permit the detection of even smaller amounts. Quantitative studies based upon the method of Clark and Reynolds,[2] suitably modified to avoid the effects of the organic material, are in progress.

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[1] Sweany, Porsche, Douglass, *Arch. Path.*, 22: 593–633, 1936.

[2] Clark and Reynolds, *Ind. and Eng. Chem., Anal. Ed.*, 8: 36, 1936.

PROLONGED SURVIVAL OF ADRENALECTOMIZED RATS TREATED WITH SERA FROM CUSHING'S DISEASE[1]

IN the latest issue of *Endocrinology* (November, 1937) McQuarrie, Johnson and Ziegler[2] present data on the electrolyte balance in the blood of a patient with Cushing's disease which lends support to the view that this disease is essentially a state of hyperfunction of the adrenal cortex. This evidence upholds the contention of Bauer,[3] held since 1933, that Cushing's disease is primarily the result of a hyperfunction of the adrenal cortex—so much so that he prefers to call the disease "Interrenalismus." Most of those who have written on phases of Cushing's disease have, however, clung to the original hypothesis of Cushing that the primary site of the disease is in the basophil cells of the pituitary.

McQuarrie and his associates demonstrated admirably how Cushing's disease is the direct opposite of Addison's disease from the point of view of clinical signs, electrolyte balance and response to therapeusis. We were independently led to the same conception of the syndrome and have hence treated two patients with Cushing's disease with a regimen of high potassium and low sodium (patients with Addison's disease are given low potassium and high sodium diets) and with x-ray therapy to the adrenals—a treatment to which one of the patients responded in a gratifying manner. Furthermore, it seemed reasonable to suspect the presence of an overabundance of adrenal cortical hormone as being the means by which the syndrome was called forth. Accordingly, under the conditions of experiment outlined below, the sera of the two patients were injected into adrenalectomized rats. The survival periods of these rats were longer than those similarly adrenalectomized and injected with the serum of normal individuals.

It should be pointed out that both patients under discussion showed the classical signs of Cushing's disease. There was obesity of facial, shoulder and trunk distribution, relatively sudden gain of weight of fifty

[1] Aided by grants from the Board of Research of the University of California and the Rockefeller Foundation of New York City.

[2] I. McQuarrie, R. M. Johnson and M. R. Ziegler, *Endocrinology*, 21: 762, 1937.

[3] J. Bauer, *Klin. Wschr.*, 12: 1553, 1933.

pounds in each of them, amenorrhea in the female and impotence in the male, hirsutism in the female and change in the texture and color of the hair in the male, purplish abdominal *lineae striae,* hypertension, plethora, polycythemia and osteoporosis.

Rats 23 to 25 days of age were used for the experiment. They were adrenalectomized by the usual method and placed on a diet of fresh white bread and tap water. In all, seven groups of animals were adrenalectomized and of these some remained uninjected, others picked at random were injected with sera of normal individuals, while the remaining were injected with the serum of each of the patients with Cushing's disease. Injection was started in the majority of rats on the sixth or seventh day, when one or two of that group had died and the remaining animals showed signs of adrenal insufficiency.

The blood was collected from both patients under sterile conditions and the serum was kept frozen. Hexylresorcinol as preservative could not be used, since it appeared to be highly toxic. Also hemolyzed blood had to be in large part discarded because of its toxicity. Even when caution was taken against these factors, human serum seemed toxic to the rats, in light of the observation that with injection of 1 cc of serum the rats died within 12 hours, whereas the uninjected controls remained living. Therefore the dosage of serum administered was from 0.2 to 0.4 cc intraperitoneally twice a day.

The uninjected control group consisting of 13 rats survived for a period, the median of which was 8.3 days. The 14 receiving normal human serum survived for a period of 8 to 13 days, a median of 10.7 days. Two died on the 13th day, one on the 12th, one on the 10th, one on the 9th, two on the 8th and the remaining 7 on the 11th day. The group injected with the serum of Patient B, consisting of 13 rats, died at a median of 14.0 days, 5 having died prematurely due to infection or accident. Two of these survived 19 days, three 17 days, one 15 days, one 14 days, one 12 days, three 11 days and the remaining two 10 days. Of the group of 7 animals injected with the serum of Patient C, two survived 18 days, two 17 days, one 16 days, one 12 days and one 11 days, with a common median for the group of 15.6.

It would appear that the lengthened survival period of completely adrenalectomized animals may be taken as indicative of the presence in these sera of a substance resembling the adrenal cortical hormone.

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THE POTASSIUM CONTENT OF SOIL BENEATH A STRAW MULCH

THERE are three prevalent types of soil management in American apple orchards. Tillage predominates in some sections, sod land with perhaps an occasional discing in others, and to a much more limited extent the mulch system is used. In the latter case the land is kept permanently in a sod (usually of nonlegumes) and straw or other material is spread beneath the branches as a mulch. This mulch is renewed from time to time so that there is practically no growth of grasses within the periphery of the area occupied by each tree.

The mulch system was at first condemned as unsound, and dire predictions were made as to the consequences. But after some forty years of continuous mulch such trees are thrifty, productive, and show no signs of deterioration beyond that shown by trees of similar age grown under other systems of culture.

In some of the fruit regions of the United States and Canada the need of other elements than nitrogen, particularly potassium, has become apparent and in many other sections the question of their need has been raised. Without discussing this somewhat controversial question as such, it may be of interest to report the potassium situation in orchards at the Ohio Agricultural Experiment Station, Wooster, under different systems of culture.

In the orchard area as a whole it was found that potassium is very low. The foliage in certain sections has shown a characteristic scorch that is usually associated with K deficiency, for several years. But when potassic salts were applied the potassium was "fixed" in the surface soil and failed to move downward into the root zone of the trees even after ten years of treatment. This had frequently been shown by others[1] and presents a serious problem of supplying trees with this element.

Since the potassium in plant material is largely water soluble it became a matter of inquiry as to whether the leachings of the straw and other mulch materials had accumulated in the surface of the soil where the superficial roots might absorb it. Preliminary "quick tests" were made by using the Thornton method,[2] and they showed to our surprise that available potassium was very high for two to three feet beneath the mulch. It was also shown that potassium was present in any considerable amount only in the first few inches of soil beneath the surface in the adja-

[1] J. T. Way, *Jour. Roy. Agr. Soc.*, 11: 313–379, 1850; F. E. Bear, "Theory and Practice in the Use of Fertilizers." John Wiley and Sons, pp. 215–217, 1929; J. S. Joffe and L. Kolodny, SCIENCE, 84: 2175, Sept. 4, 1936.

[2] S. F. Thornton, S. D. Conner and R. R. Fraser, Purdue Univ. Agr. Exp. Sta. Cir. 204. Rev. August, 1936.

cent 38-year old bluegrass sod and was notably deficient in the entire cultivated area. These preliminary tests prompted quantitative determinations in the different areas. The quantitative determinations were made by leaching the soil with normal neutral ammonium acetate and then determining the potassium in the leachate by a standard method.[3]

These quantitative results show conclusively that potassium is very high to a depth of from 24 to 32 inches and sometimes to 40 inches beneath the 38-year old mulch. This is highly significant in light of the characteristic fixation of potash salts in the surface inch and a half to two inches of surface soil. In no case was potash fertilizer applied to the mulched trees.

Samples of soil taken from the grass area between the trees showed no such accumulation of available potassium. Those taken from an adjacent unfertilized plot which has been in a three-year rotation of potatoes, wheat and clover showed a very low potassium content even in the first few inches of top-soil.

Another orchard nearby which has been in the different systems for twenty-two years shows similar results. The soil under the mulched trees has a high available potassium content to the depth of the rooting area of the trees, while the soil under the trees kept in the tillage-cover crop system is very low in this element. For example, the soil beneath two trees in the mulch system has a content of 1,000 pounds per acre of available K at a depth of 24 inches, while the soil beneath a tree 40 feet away in cultivation contained less than 175 pounds at the same depth.

The authors offer no explanation at the present time of the occurrence of the potassium to such a depth beneath the mulch. This finding, however, would indicate that fruit trees grown under the mulch system would not need potash applications even on soils greatly deficient in potassium.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN INTERVAL COMPUTER

BEING required by the exigencies of a certain problem to convert large numbers of time intervals as measured in the ordinary way by clock times to hours and decimal fractions of hours, the writer has devised the following instrument for this purpose.

The instrument (of which a portion is shown in Fig. 1) consists of two flat metal discs, an "inner disc" some inches in diameter and an "outer disc" some 7 inches in diameter, so fastened by a bolt through their centers that the inner may be rotated concentrically with the outer. The inner disc is graduated around its periphery from 0 to 24 hours, and each hour is further divided into the smallest time interval it is desired to deal with. (In Fig. 1 the instrument is divided into quarter-hours.)

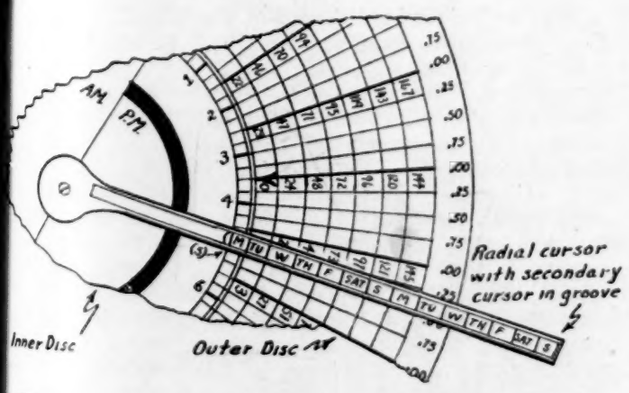

FIG. 1. Relevant portion of an interval computer set to show a start at 3: 30 P.M. on a Tuesday, and a termination at 5 P.M. on any succeeding day.

The outer disc is divided by radial lines into the same divisions, and has also, depending upon the number of days range it is desired to handle, a number of concentric "day-circles" separated from each other by concentric circular lines. Starting at any radius (henceforth known as the "zero radius") and on the innermost day-circle, the short intercepts of the hour-radii are numbered consecutively from 0 to 24 around this innermost day-circle, stepping outward one day-circle and continuing with 25 to 48 on the second day-circle, and so on. Finally the radii between hours are marked on the periphery of the disc with their decimal equivalents, starting at zero with each hour.

On the bolt holding the two discs together is mounted a "radial cursor," of which one edge, if produced, would pass through the center of the pivot, *i.e.*, this edge is a radius. (The edge nearest the bottom of the page in Fig. 1 is the radial edge.) The radial cursor is grooved on its exposed face to carry a sliding "secondary cursor" marked by cross-lines the same distance apart as the width of a day circle, with the spaces between these lines marked with the days of the week as shown in the figure. There should be twice as many intervals as there are day-circles.

In operation the inner disc is rotated with reference to the outer until the time appropriate to the start of the experiment is opposite the zero radius of the outer disc. The secondary cursor is then slid along in its groove so that the day of the start comes opposite the innermost day-circle. In Fig. 1, the instrument is

[3] R. H. Bray and F. M. Willhite, *Ind. and Eng. Chem.*, 1: 3, 144, July 15, 1929; V. H. Morris and R. W. Gerdel, *Plant Physiol.*, 8: 315–319, 1933.

shown as set for a start at 3:30 P.M. on a Tuesday. The radial cursor is now rotated to a position such that its radial edge coincides with the time of the termination of the experiment as marked on the periphery of the inner disc. The integral number of hours elapsed is then read on the scale of the outer disc, picking out the proper day-circle by reference to the secondary cursor, while the added decimal portion is found from the marking at the end of the radial edge of the radial cursor where it crosses the scale around the periphery of the outer disc. In Fig. 1 the instrument is set for an experiment terminating at 5 P.M. If this is on the following Wednesday, then 25.500 hours have elapsed, while if it is on the following Monday, 145.500 hours have elapsed.

Owing to the way in which the graduations step outward as one goes around the successive day-circles, it is necessary to make an adjustment in the position of the secondary cursor for some computations. This adjustment may be made by following this rule: "When computing time intervals which terminate at a time located between midnight as shown on the inner disc and the zero radius of the outer disc, push the secondary cursor inward one day before selecting the day-circle from which the number of integral hours is read off. Otherwise have it set as directed above."

The writer's instrument is graduated to the nearest 5 minutes over an interval of 10 days, the scales being marked with india ink on heavy drawing paper cemented to the discs. If the discs were made of white celluloid and engraved by machine, no doubt the graduations could be made to the nearest minute or less, over an interval of as many days as necessary, depending on the size of the outer disc.

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GIEMSA PREPARATION FOR STAINING BLOOD FILMS

THERE have been many varieties of blood stains proposed, and each stain has its peculiar advantages. In a large proportion of clinical laboratories, where many blood films are stained daily, Wright's stain is generally found to be satisfactory and is relatively inexpensive. However, some laboratory workers prefer the more precise results obtained from other stains in the Romanowsky series. Giemsa's modification has been found to be very satisfactory as a routine blood-stain as well as for blood parasites. Its chief disadvantage is its cost.

For several years the writer has prepared blood films containing avian malarial parasites, using the Giemsa method exclusively. Ready prepared solutions of Giemsa generally cost about $12.00 per eight-ounce bottle. The cost of eight ounces of prepared Wright's stain, on the other hand, is but $2.85. This difference in price means a great deal to private laboratories and to many institutions. Some workers, even though preferring the Giemsa method, use Wright's stain regularly to reduce the expense involved.

The following method for preparing Giemsa stain, although not conforming to the usual technique suggested, has been found to be very satisfactory by the writer. The resulting stain costs about $3.25 per eight ounces and gives uniformly well-stained blood films. In laboratories where a great deal of stain is used the cost of Giemsa so prepared is little more than Wright's.

Azur II–eosin	3.0 gms.
Azur II	0.8 gms.
Glycerin (c.p.)	250.0 gms.
Methyl alcohol, absolute (neutral), acetone free	250.0 gms.

Dissolve the Azur II and Azur II–eosin in the methyl alcohol in an Erlenmeyer flask. Shake well for fifteen minutes, add the glycerin, shake for ten minutes and filter through a moderately fine grade of filter paper. Collect the filtered stain in a bottle and discard the undissolved residue.

There is generally quite a bit of stain that does not dissolve. This, however, seems to make very little difference in the character of the resultant stained blood films. Results have been equally satisfactory with human blood and avian blood. Malarial parasites are brought out sharply, with distinct differentiation of chromatin and cytoplasm.

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